(12) UK Patent Application (19) GB (11) 2 300 910 (13) A

(43) Date of A Publication 20.11.1996

(21) Application No 9507939.8

(22) Date of Filing 19.04.1995

(51) INT CL[6]
F25D 16/00 , H05K 7/20

(52) UK CL (Edition O)
F4U U24A2 U24B1

(56) Documents Cited
US 4619114 A

(58) Field of Search
UK CL (Edition N) F4U U24A2
INT CL[6] F25D , H02B , H04B , H05K

(71) Applicant(s)
Rainford Group Ltd

(Incorporated in the United Kingdom)

Brindle Avenue, New Century Park, COVENTRY, CV3 1JG, United Kingdom

(72) Inventor(s)
Richard Mills
Steve Blackburn
Gerry Smith

(74) Agent and/or Address for Service
Christopher Stephen Tunstall
Dibb Lupton Broomhead, 117 The Headrow, LEEDS, LS1 5JX, United Kingdom

(54) Electronic cabinet temperature regulation

(57) A temperature regulation unit for an electrical cabinet includes a heat exchanger 22, and a refrigerating circuit consisting of a compressor 24, a condenser 26 and an evaporator 28. Air is drawn from the interior of the cabinet, passes through the heat exchanger 22, across the evaporator 28 and is returned to the cabinet. Ambient air is drawn either through the heat exchanger 22 or across the condenser 26 and then expelled. A control flap 44 determines which. In normal operation, the flap 44 is positioned to communicate the heat exchanger with the ambient air flow. If the temperature of the interior of the cabinet rises above its maximum acceptable value, the flap is moved and the compressor 24 started up. The unit then goes into refrigeration mode. Once the interior temperature reaches the lower end of its acceptable range of temperatures the control circuit switches the compressor off. If the temperature of the interior of the cabinet is greater than ambient temperature, the flap is moved once again to go back to heat exchange mode. However, if ambient temperature exceeds the temperature of the interior of the cabinet, the flap 44 stays where it is until the temperature of the interior of the cabinet rises above ambient temperature, effectively maintaining the interior of the cabinet insulated for the time being. This arrangement prevents the heat exchanger 22 contributing to the heating effect inside the cabinet.

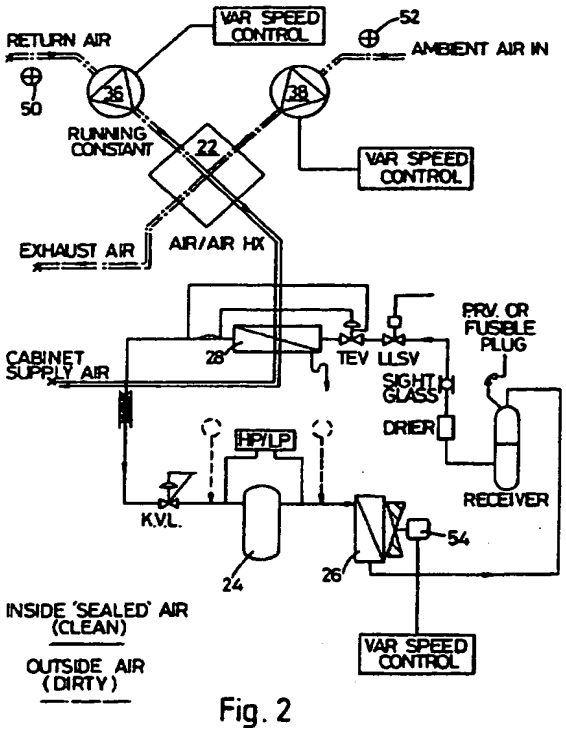

Fig. 2

GB 2 300 910 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

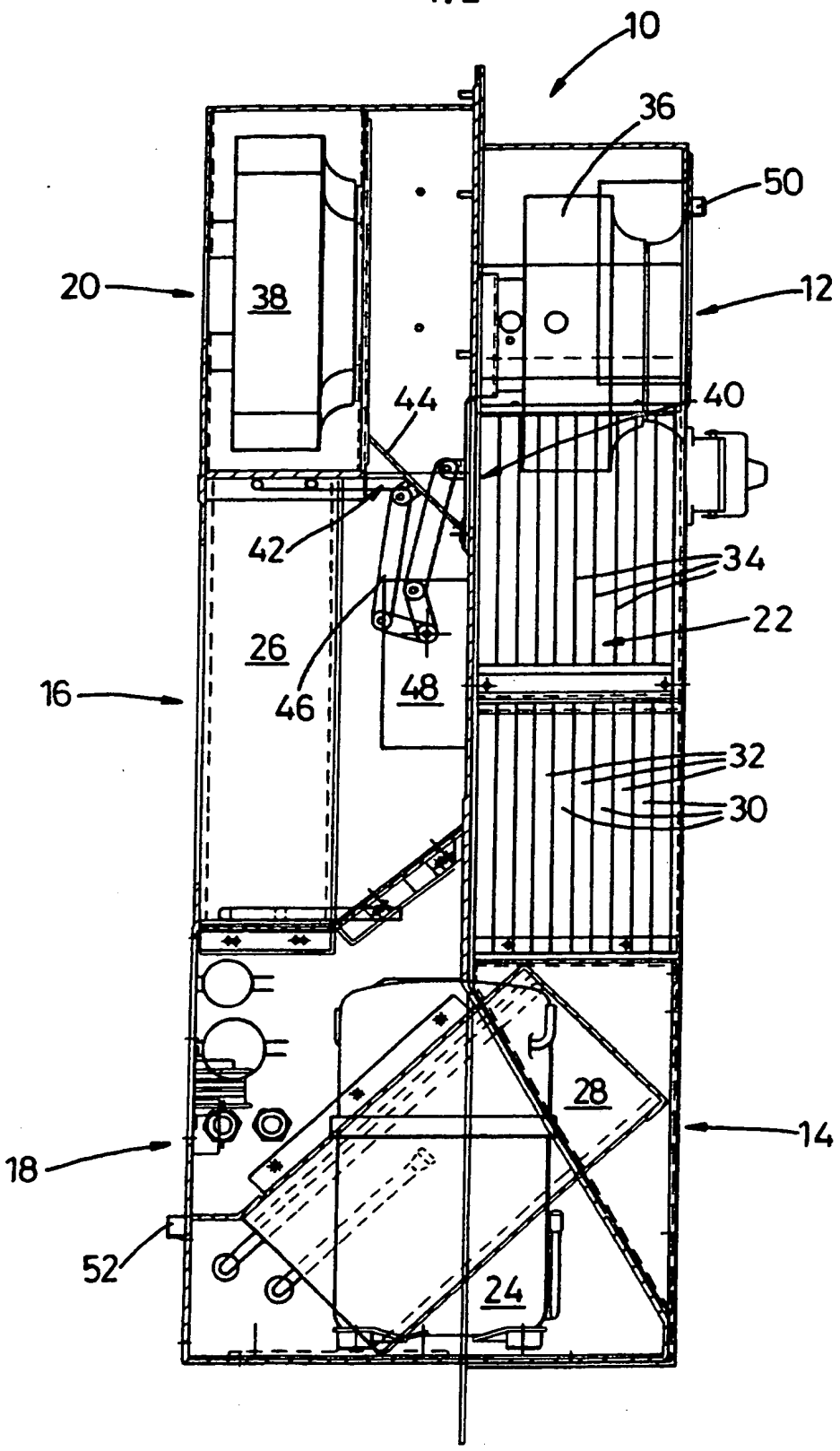

Fig. 1

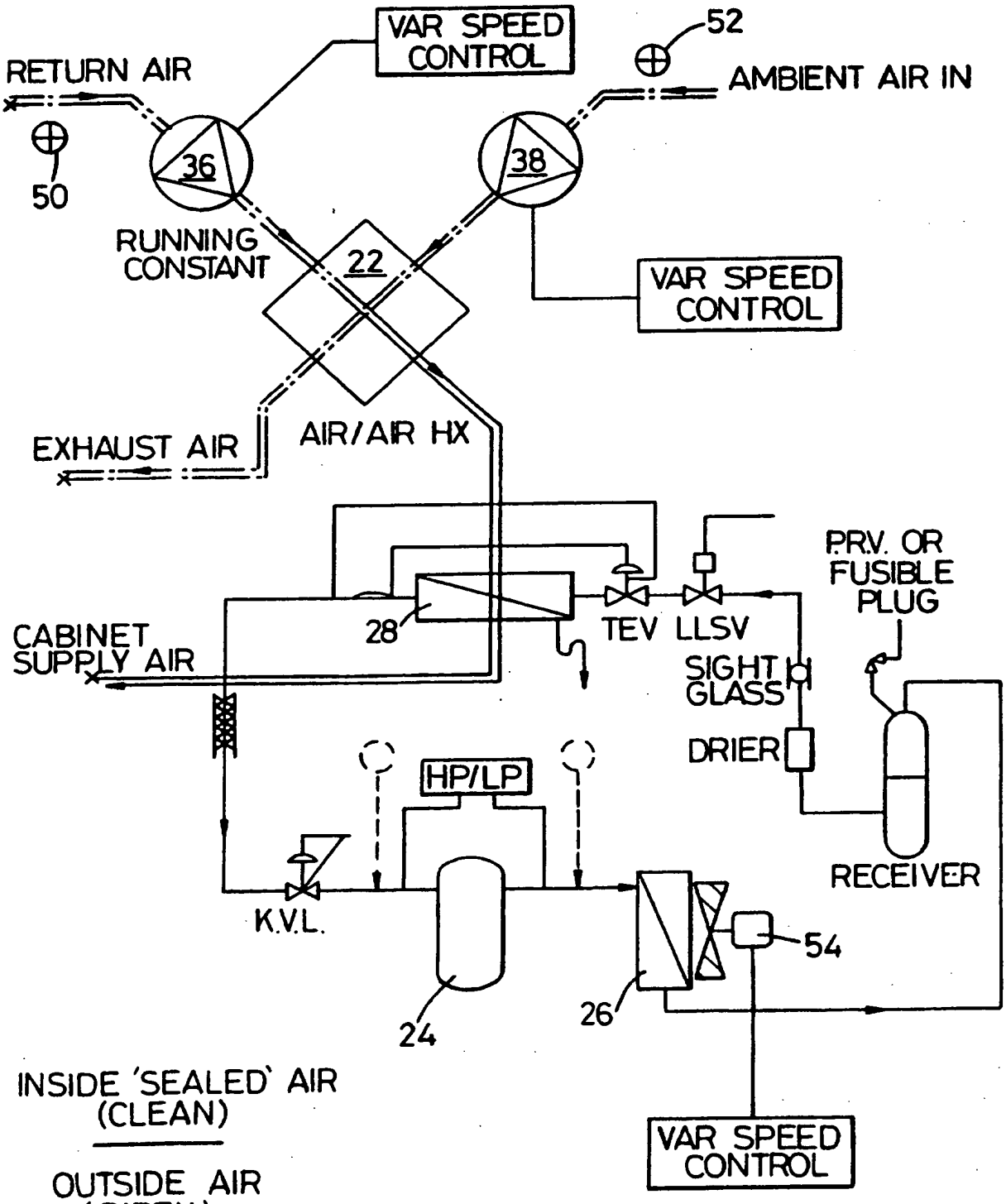
VAR SPEED CONTROL
52
RETURN AIR
AMBIENT AIR IN
50
36
38
RUNNING CONSTANT
22
VAR SPEED CONTROL
EXHAUST AIR
AIR/AIR HX
P.R.V. OR FUSIBLE PLUG
CABINET SUPPLY AIR
28
TEV
LLSV
SIGHT GLASS
DRIER
HP/LP
RECEIVER
K.V.L.
54
24
26
INSIDE 'SEALED' AIR (CLEAN)
OUTSIDE AIR (DIRTY)
VAR SPEED CONTROL

Fig. 2

ELECTRONIC CABINET TEMPERATURE REGULATION

This invention relates to temperature regulating units for use with electronic cabinets, i.e. cabinets which house electronic components or electrical equipment.

In many applications, e.g. transceiver base stations, the housing cabinets must meet extremely stringent operating standards. The interior of the cabinet must be kept free of air-borne particles and thus there must be no mixing of the air inside the cabinet with ambient air. The temperature of the interior of the cabinet must be maintained within a relatively narrow band, typically between 30 and 40 degrees C, irrespective of ambient temperature. The interior temperature should be maintained reasonably steadily without, for example, allowing the temperature to cycle between its optima, as such thermal cycling can give rise to premature fatigue. Noise must be kept to a minimum to maintain a reasonably pleasant working environment for the equipment operators. Power consumption should be minimised.

There are a number of temperature regulating units availably nowadays which to greater or lesser degrees achieve the objects described above. One such unit makes use of a heat exchanger or recuperator to maintain the temperature of the interior of the cabinet at relatively low ambient temperatures. At higher ambient temperatures, when the heat exchanger is incapable of maintaining the temperature of the interior of the cabinet within acceptable limits, a refrigeration circuit is started up once the temperature of the interior of the cabinet exceeds its maximum acceptable value. Once the refrigeration circuit has reduce the temperature of the interior of the cabinet to its minimum acceptable value, the circuit is shut off again and the heat exchanger then provides cooling until such time as the refrigeration circuit is again required. This arrangement is reasonably successful for a range of ambient temperatures, but suffers if ambient

temperature exceeds the minimum acceptable value of the temperature of the interior of the cabinet. In that case, when the refrigeration circuit is shut off, ambient temperature actually exceeds the temperature of the interior of the cabinet and the heat exchanger only serves to increase the temperature of the interior of the cabinet. An alternative would be to keep the refrigeration circuit running, but this poses immense difficulties in controlling the efficiency of the circuit so as not to overcool the electrical equipment and is expensive in terms of power consumption.

The present invention provides a temperature regulation unit in which the above problem is alleviated.

According to the present invention, there is provided a temperature regulating unit for a cabinet, the unit comprising:

interior inlet and outlet ports through which the unit is adapted to take air from and return it to the interior of the cabinet;

exterior inlet and outlet ports through which the unit is adapted to take in and return ambient air;

a heat exchanger having first and second groups of air passages in thermal contact with one another, no passage of either group being in communication with any passage of the other group;

a refrigeration circuit including a compressor, a condenser and an evaporator; and

a control switch operable to switch between first and second operating modes of the unit:

a first mode in which ambient air entering an exterior inlet port passes through the first group of air passages in the heat exchanger and exits from an exterior outlet port and air entering an interior inlet port passes through the second group of air passages in the heat exchanger and exits from an interior outlet port without mixing with the ambient air; and

a second mode in which ambient air entering an exterior inlet port passes across the condenser and exits from an exterior outlet port and air entering an interior inlet port passes across the evaporator and exits from an interior outlet port without mixing with, and without coming into thermal contact in the heat exchanger with, the ambient air.

Although the unit itself has two modes of operation, the first in which cooling is provided by the heat exchanger and the second in which cooling is provided by the refrigeration circuit, there is in fact a third mode of operation. The third mode is constituted by the control switch being switched to the second operating mode, but the compressor being shut off so that the refrigerating circuit is not operating. Because with the control switch switched to the second operating mode there is no thermal contact in the heat exchanger between ambient air and air from the interior of the cabinet, the interior of the cabinet is effectively insulated from the exterior. This third mode can be brought into operation when the temperature of the interior of the cabinet is lower than ambient temperature.

For simplicity of control switching, it is preferred that there be one interior inlet port and one interior outlet port and that in both the first and second operating modes, air entering the interior inlet port passes through the second group of air passages in the heat exchanger and across the evaporator before exiting from the interior outlet port. This arrangement allows the control switch to operate only on the ambient air pathway with in the unit.

To realise the advantages of the third operating mode, it is preferred that the unit further comprise control means responsive to the temperature of the interior of the cabinet and ambient temperature and adapted to operate as follows:

to start up the compressor and operate the control switch to switch to the second operating mode when the

temperature of the interior of the cabinet rises above a higher threshold value;

to shut off the compressor when the temperature of the interior of the cabinet falls below a lower threshold value; and

to operate the control switch to switch to the first operating mode when either the temperature of the interior of the cabinet falls below the lower threshold value but remains above ambient temperature or when the compressor has been shut off and the temperature of the interior of the cabinet rises above ambient temperature.

Such control means will operate to maintain the temperature of the interior of the cabinet between the lower and higher threshold values, typically 30 and 40 degrees C, and ensure that the heat exchanger is operating only when the temperature of the interior of the cabinet exceeds ambient temperature.

For ease of construction, the control switch may include a movable flap which operates to open and close air pathways within the unit.

The present invention will now be described with reference to the accompanying drawings in which:

fig. 1 is a diagrammatic side view of a temperature control unit; and

fig. 2 is a schematic of the unit of fig. 1.

As can be seen from fig. 1, the temperature regulation unit 10 includes an interior inlet port 12, an interior outlet port 14, an upper exterior inlet port 16, a lower exterior inlet port 18 and an exterior outlet port 20. The unit also includes a heat exchanger 22, and a refrigerating circuit consisting of a compressor 24, a condenser 26 and an evaporator 28. The heat exchanger 22 consists of first and second groups of air passages 30, 32 which cross one another at 90 degrees. The heat exchanger is made from a number of spaced, square plates 34 which define the air

passages 30, 32 between them. Alternate air passages 30, 32 are blocked off on alternate sides of the cuboid formed from the stack of plates 34, thus defining the groups of air passages. The long diameters of the heat exchanger 22 are vertical and horizontal, so that the air passages make an angle of 45 degrees with the horizontal.

Air is drawn from the interior of the cabinet (not shown) via the interior inlet port 12 by the interior fan 36, passes through the second group of air passages 32 in the heat exchanger 22, across the evaporator 28 and is expelled via the interior outlet port 14. An exterior fan 38 is provided to drive the flow of ambient air through the unit. There are two flow paths which ambient air may take within the unit. Air may be drawn in through the lower exterior inlet port, through the first group of air passages 30 in the heat exchanger 22, out of the heat exchanger via a first internal opening 40 and then out of the exterior outlet port 20. Alternatively, air may be drawn in through the upper exterior inlet port 16, across the condenser 26, through a second internal opening 42 and then out of the exterior outlet port 20. A further condenser fan 54 (fig. 2) is provided to promote air flow across the condenser.

A control flap 44, operated via a linkage 46 by an actuator 48 serves to open one or other of the internal openings while closing off the remaining opening. Internal 50 and external 52 temperature transducers are provided, the outputs of which are supplied to a control circuit, such as a microprocessor, the control circuit controlling operation of the actuator 48 and the compressor 24 and the speeds of the three fans 36, 38, 54. The internal temperature transducer 50 is situated adjacent to the interior inlet port so that it measures the temperature of the extracted air.

Operation of the unit is as follows. Initially, the control flap 44 is set to close the internal opening 40 from the heat exchanger. The compressor is shut off. A

heater (not shown) within the unit or the cabinet increases the internal temperature of the cabinet to, for example, 20 degrees C, at which temperature it is safe for the electrical equipment within the cabinet to be switched on. Both the internal and external fans 36, 38 are switched on.

Once the temperature of the interior of the cabinet rises above ambient temperature, the flap 44 is moved by the actuator 48 so as to close the internal opening 42 and communicate the heat exchanger with the exterior fan 38. Heat exchange takes place within the heat exchanger 22 and the speed of the interior and exterior fans 36, 38 is controlled according to the outputs from the two temperature transducers 50, 52 to maintain an approximately steady temperature inside the cabinet.

If ambient temperature rises of the electrical equipment increases its heat output, this is compensated by an increase in the speed of the two fans 36, 38. However, ambient temperature may be so high that the heat exchanger is incapable of cooling the equipment sufficiently to maintain its temperature within acceptable limits even when the two fans are operating at maximum speed. Once the temperature of the interior of the cabinet rises above its maximum acceptable value, e.g. 40 degrees C, the control circuit operates the actuator 48 to close the first internal opening 40, thus opening the second internal opening 42, and starts up the compressor 24 and the condenser fan 54 (fig. 2). The unit then goes into refrigeration mode, its second mode of operation.

Under refrigeration, the temperature of the interior of the cabinet decreases. Once it reaches the lower end of its acceptable range of temperatures, e.g. 30 degrees C, the control circuit switches the compressor off. At this stage, if the temperature of the interior of the cabinet is greater than ambient temperature, the flap is actuated once again to close the second internal opening 42 and open the first 40, taking the unit back into its first mode of

operation (heat exchanging). However, if ambient temperature exceeds the temperature of the interior of the cabinet, the flap 44 stays where it is until the temperature of the interior of the cabinet rises above ambient temperature, effectively maintaining the interior of the cabinet insulated for the time being. This arrangement prevents the heat exchanger 22 contributing to the heating effect inside the cabinet.

CLAIMS

1. A temperature regulating unit for a cabinet, the unit comprising:

interior inlet and outlet ports through which the unit is adapted to take air from and return it to the interior of the cabinet;

exterior inlet and outlet ports through which the unit is adapted to take in and return ambient air;

a heat exchanger having first and second groups of air passages in thermal contact with one another, no passage of either group being in communication with any passage of the other group;

a refrigeration circuit including a compressor, a condenser and an evaporator; and

a control switch operable to switch between first and second operating modes of the unit:

a first mode in which ambient air entering an exterior inlet port passes through the first group of air passages in the heat exchanger and exits from an exterior outlet port and air entering an interior inlet port passes through the second group of air passages in the heat exchanger and exits from an interior outlet port without mixing with the ambient air; and

a second mode in which ambient air entering an exterior inlet port passes across the condenser and exits from an exterior outlet port and air entering an interior inlet port passes across the evaporator and exits from an interior outlet port without mixing with, and without coming into thermal contact in the heat exchanger with, the ambient air.

2. A temperature regulating unit according to claim 1 in which there is one interior inlet port and one interior outlet port and in which in both the first and second operating modes, air entering the interior inlet port passes through the second group of air passages in the heat exchanger and across the evaporator before exiting from the interior outlet port.

3. A temperature regulating unit according to claim 1 or claim 2 further comprising control means responsive to the temperature of the interior of the cabinet and ambient temperature and adapted to operate as follows:

to start up the compressor and operate the control switch to switch to the second operating mode when the temperature of the interior of the cabinet rises above a higher threshold value;

to shut off the compressor when the temperature of the interior of the cabinet falls below a lower threshold value; and

to operate the control switch to switch to the first operating mode when either the temperature of the interior of the cabinet falls below the lower threshold value but remains above ambient temperature or when the compressor has been shut off and the temperature of the interior of the cabinet rises above ambient temperature.

4. A temperature regulating unit according to any one of claims 1-3 in which the control switch includes a movable flap which operates to open and close air pathways within the unit.

5. A temperature regulating unit for a cabinet, the unit being substantially as described herein with reference to the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) -10-	Application number GB 9507939.8
Relevant Technical Fields (i) UK Cl (Ed.N) F4U U24 A2 (ii) Int Cl (Ed.6) F25D, H02B, H04B, H05K	Search Examiner MR G WERRETT Date of completion of Search 27 JULY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-5

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	US 4619114	(R WILSON) see heat exchanger 22 and refrig. unit 16	1

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).